The Human Systems Integration Division advances the design, development and operations of complex aerospace systems through analysis, experimentation, modeling and simulation of human performance and human-automation interaction to enable safe and efficient mission operations.

Human-Machine Interaction

The Human-Machine Interaction Group contributes to the development of measurably better NASA software through careful application of Human-Computer Interaction (HCI) methods. The group follows an iterative process that consists of user research, interaction design, software development, and usability evaluation. This approach enables us to deploy and integrate mission software, with the right functionality and user interfaces, for scientists and engineers on some of NASA's largest programs.

Human Performance

The Human Performance Group performs research and technology development to enhance health, productivity, and safety in aerospace environments. The group develops advanced interfaces, models of human performance, tools for monitoring performance, and countermeasures to mitigate performance deficits. The group includes labs that focus on advanced multi-modal interfaces, auditory displays, performance modeling, psychophysiology, telerobotics, vibration impacts on performance, gaze tracking, virtual environments, vision science, and visuomotor control.

Integration and Training

The Integration and Training Group is committed to improving the efficiency and safety of the Air Transportation System, with emphasis on mid-term and long-term requirements. This group develops and evaluates methods drawn from Human Factors and related disciplines for the integration of humans as intrinsic to the Air Transportation System as a whole. The group includes full-mission laboratories associated with air traffic management, flight deck and air-ground procedures, and surface operations. It also includes labs dedicated to design of complex systems, fatigue countermeasures, training, human-automation teaming, and unmanned aerial systems.

Design: Phil So
Printed: August 2016

Human Systems
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Human Systems Integration Division

Human-Centered Design and Operations of Complex Aerospace Systems 2017

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Advancing Design and Operations of Complex Aerospace Systems

Humans are the most critical element in system safety, reliability, and performance. Our highly generative and adaptive problem-solving capabilities will continue to enable resilient operations across the gamut of aerospace applications even as increasingly intelligent software systems come on-line. These advances in computing power and communications, increased automation and access to distributed information resources for collaboration, monitoring and control, will contribute new challenges for humans as critical decision-makers in complex systems.

Dr. Alonso Vera, Division Chief

In aviation, humans are the backbone of a national aviation system that is straining to meet growing consumer demands. In space, long-duration missions and reusable launch vehicles will increase the requirement for safe and effective human performance in the harsh environments surrounding our planet. For both aeronautics and space, the design of hardware and software systems must address the need for safe, efficient and cost-effective operations, maintenance and training, both in flight and on the ground.

The Human Systems Integration Division is creating and applying a new understanding of how individuals and teams assimilate and act on information in pursuit of goals critical to the success of NASA missions

Strategic Goals

- To enable functional human-autonomy teaming through the design and development of increasingly intelligent systems and augmentive/adaptive technologies.
- To enhance aviation safety and performance by designing human-centered automation and interfaces, decision support tools, evaluation techniques, training, and team and organizational practices.
- To extend human capabilities in space by advancing our knowledge of human performance during space missions and developing tools, technologies, and countermeasures for safe and effective space operations.
- To advance the fundamental understanding of how humans process information, make decisions, and collaborate with human and machine systems.

Human-Machine Interaction

Mobile Tools for Dynamic Re-Planning by Astronauts

The Human-Computer Interaction Group is developing software tools for astronauts to coordinate and plan their own daily activities, something that is currently done entirely by ground control. A tool called Playbook has been tested by a crew of NEEMO (NASA Extreme Environment Mission Operations) during a two-week underwater missions off the coast of Florida in the world's only undersea research station. A key goal for Playbook on NEEMO was to assess crews' ability to reschedule some of their own activities without input from ground, and to allow the NEEMO mission to better simulate the time-delay associated with long distance missions such as trips to Mars. Playbook has already been deployed to the International Space Station (ISS) and is scheduled to be used as part of a study on crew autonomy. Playbook is based on systems developed by the Human-Computer Interaction Group for the Mars Exploration Rover mission, the Phoenix Mars Lander mission, the Mars Science Laboratory, and ISS crew schedulers. Playbook is a notable extension of those previous systems in that it is designed for direct use by the crew with minimal training.

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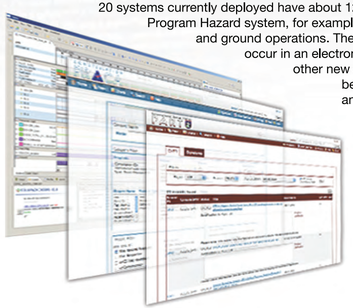
Integrated Information Systems

The Human-Computer Interaction Group also works on the development of highly usable integrated information systems for NASA's major space programs including Orion, Space Launch Systems (SLS), and the International Space Station. The 20 systems currently deployed have about 12,000 users and hold about 300,000 records across NASA. The Cross Program Hazard system, for example, contains all of the hazard safety analyses for the integrated vehicle and ground operations. The system enables the SLS-defined signature and baselining process to occur in an electronic system storing historically paper processes. The integration with other new and legacy systems enables analysts to create direct traceability between programmatic safety requirements and their underlying analyses. The system also includes the capability to output reports that highlight changes between versions of the analyses so that reviewers can quickly identify changes as the analyses mature without scanning historical versions where printouts can exceed 100 pages. The Cross Program Hazard system is one of several production systems the Human-Computer Interaction Group has deployed to enable the creation, baselining, and integration of engineering data systems for NASA's space flight missions.



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Human Performance

Eye Movement Analysis

The Visuomotor Control Lab is developing a new eye-movement technology, Comprehensive Oculometric Behavioral Response Assessment (COBRA), as a tool for assessing mild-to-moderate traumatic brain injury (TBI) and for measuring fatigue. COBRA uses high fidelity eye movements to diagnose and measure mild impairments of brain function. This recently patented technology also has potential space flight applications as a tool to quantitatively detect degradations in human visual and vestibular function due to microgravity exposure. A critical feature of COBRA is that its design allows data to be collected rapidly, inexpensively, and non-invasively. This enables the technology to be deployed in the field under conditions where access to a neurologist or magnetic resonance imaging would be impractical.

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Psychophysiology Research

The Psychophysiology Research Laboratory is evaluating a prototype medical monitoring system consisting of an intelligent biosensor garment worn on the upper body and a headband fitted with sensors. The system includes software and technology that measure vital signs, sleep quality, and activity level of the wearer. To support this work, researchers participated in flight analog studies to validate system performance, usability, and comfort with crew during Human Exploration Research Analog (HERA) missions. Medical monitoring capabilities alone, or integrated with other health-related data and decision support technologies, could fundamentally change the way crew health and performance is addressed during NASA's future deep space missions. The primary objective of this work is to assess and correct adverse physiological and behavioral responses to the extreme environments encountered in space travel, first responder scenarios, and military operations. The countermeasures developed in this laboratory involve training voluntary control of human autonomic and central nervous system function (Autogenic Feedback Training Exercise or AFTE).

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Photo Credit: Astroskin, Carré Technologies

Integration and Training

Airspace Traffic Management

In order to test new Air Traffic Management concepts, the Airspace Operations Laboratory conducts human-in-the-loop simulations with pilots and air-traffic controllers in realistic software analog environments. One such simulation explored the challenge of "Integrated Demand Management." In this case, the specific study focused on how to address chronic equity, throughput and delay issues associated with New York's high-volume airports by operationally integrating two capabilities within the Federal Aviation Administration's (FAA) NextGen air traffic management tool set – the Collaborative Trajectory Options Program (CTOP) and Time-Based Flow Management (TBFM) - that were designed to better manage traffic demand within the National Air Traffic System. Retired traffic management experts along with representatives from the Port Authority of New York and New Jersey and the FAA's Air Traffic Control System Command Center participated in the week-long simulation. Initial results from this exploratory study suggest that combined operations, integrated as tested here, could indeed enable more balanced management among flights and achieve the target throughput.

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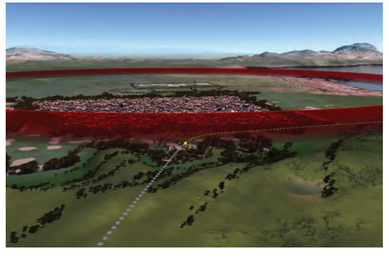
Unmanned Aerial Systems (UAS)

The Airspace Operations Lab (AOL) is also a national leader in the integration of Unmanned Aerial Systems (UAS) in the National Air Space. This emerging area of research is known as UAS Traffic Management (UTM) and is of great public and commercial interest because of the rapid increase in the use of low-altitude UAS. Many beneficial civilian applications of UAS have been proposed, from goods delivery and infrastructure surveillance, to search and rescue, and agricultural monitoring. The AOL participates in major UAS tests involving the Federal Aviation Administration (FAA) across numerous test sites and hosts new UTM technologies to enable coordination of traffic management across the sites. The UTM systems are designed to enable safe and efficient low-altitude airspace operations by providing services such as airspace design, corridors, dynamic geofencing, severe weather and wind avoidance, congestion management, terrain avoidance, route planning and re-routing, separation management, sequencing and spacing, and contingency management. UTM is essential to the accelerated development and use of civilian UAS applications and has drawn considerable media attention.



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